Space Weather Technical Forecast

Issued on Sunday, 04 December 2022 at 01:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active high energy electron fluence. Daily chance of M-flares. Chance G1/Minor Storms, mainly day 4 (7th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one impulsive M1.3 flare at 03/1741 UTC from near a new region (Cso/Beta) on the northeast limb, along with a few C-class flares. Large region AR3153 Fho/Beta in the southeast remains a stable and mature spot with a simple magnetic configuration. Most notable growth was observed in AR3155 Dai/Beta in the north disc, just west of centre. There is currently a total of eight sunspot regions, with the majority of those in the northeast, but generally small and simple. No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Declining influence of CH51/+ was observed, with elevated solar wind speeds at L1 from ACE/DSCOVR easing from around 600km/s to near 500km/s. Total IMF, Bt, was generally weak between 2 and 5nT. The north-south component Bz was variable between -5nT and +4nT. Phi angle was largely positive at first (away from the Sun), but became more variable after 03/1200 UTC. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES-16 has been High throughout, peaking at 17480 pfu at 03/1740 UTC. The associated 24 hour Fluence was above the Active (1e8 integrated pfu) threshold throughout with an increasing trend. Observed fluence at 04/0000 UTC was 5.71e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low activity expected, with further C-flares, and a daily chance of rising to Moderate with isolated M-flares possible.

Solar Wind / Geomagnetic Activity: A slow CME from a filament eruption on the 29th Nov may arrive at Earth early on day 1 (4th), however this is low confidence. Ongoing fast winds from CH51/+ are expected to decline towards background, before the next high speed stream arrives, from CH53/-. This most day 4 (7th), with peak winds 500-600 km/s likely as Earth moves into the fast wind. Consequently mainly Quiet to Unsettled geomagnetic activity expected through days 1-3 (4th to 6th), although any CME arrival will bring the chance of a spell of Active to G1/Minor Storms day 1 (4th). Activity increasing to Unsettled to Active with a chance of G1/Minor storm intervals day 4 (7th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES-16, is expected to remain at Background throughout. High energy electron flux (greater than 2 MeV), as observed by GOES-16, is expected to remain predominantly High, until at least day 4 (7th), with Fluence levels persisting above the Active (1e8 integrated pfu) fluence threshold. There is a chance of a brief drop out in flux day 1 (4th) from any CME arrival, however this is low confidence.

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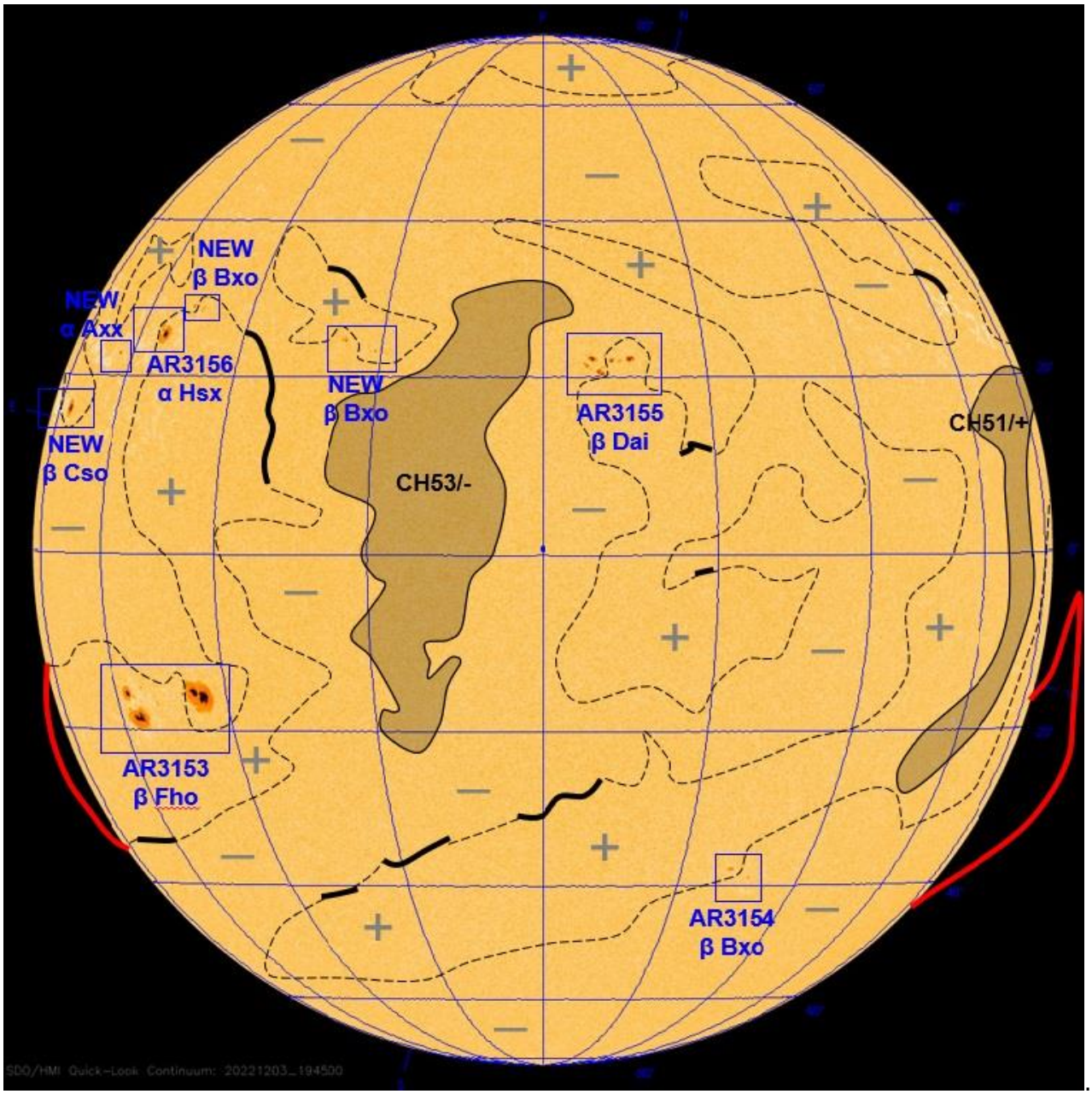
Figure 1. Solar Analysis Valid 03/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Filament eruption on 29 Nov, and its associated CME has been assessed as slow, but with the possibility of an Earth-directed component, although this is low confidence. MOSWOC ENLIL output suggesting any arrival is most likely to occur early day 1 (4th).

Otherwise ongoing fast wind environment from CH51 is expected to continue declining day 1 (4th) potentially towards background levels, as supported by MOSWOC enlil. The next enhancement is expected to be the arrival of the fast wind from CH53/- . This feature has markedly increased in size on this rotation, and enlil suggests peak winds of 500-600 km/s arriving on day 4 (7th). As we approach the December Solstice, geomagnetic response to these fast winds arrivals are less likely to be significant, however there is still a chance of G1/Minor Storm intervals, especially with this coronal hole being a persistent feature that is larger and more prominent on this rotation.

Mainly Quiet to Unsettled geomagnetic activity expected through days 1-3 (4th to 6th), although any CME arrival will bring the chance of a spell of Active to G1/Minor Storms day 1 (4th). Activity increasing to Unsettled to Active with a chance of G1/Minor storm intervals day 4 (7th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	20	1	10	40
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/1246 and 30/0730	Partial	Filament	SE	300km/s and 320km/s	04/0600 +/- 9hrs	Modelled as 2 CMEs. Limited shock expected. Low confidence.

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Figure 2a: Enlil Potential arrival of weak CME visible early on 4th

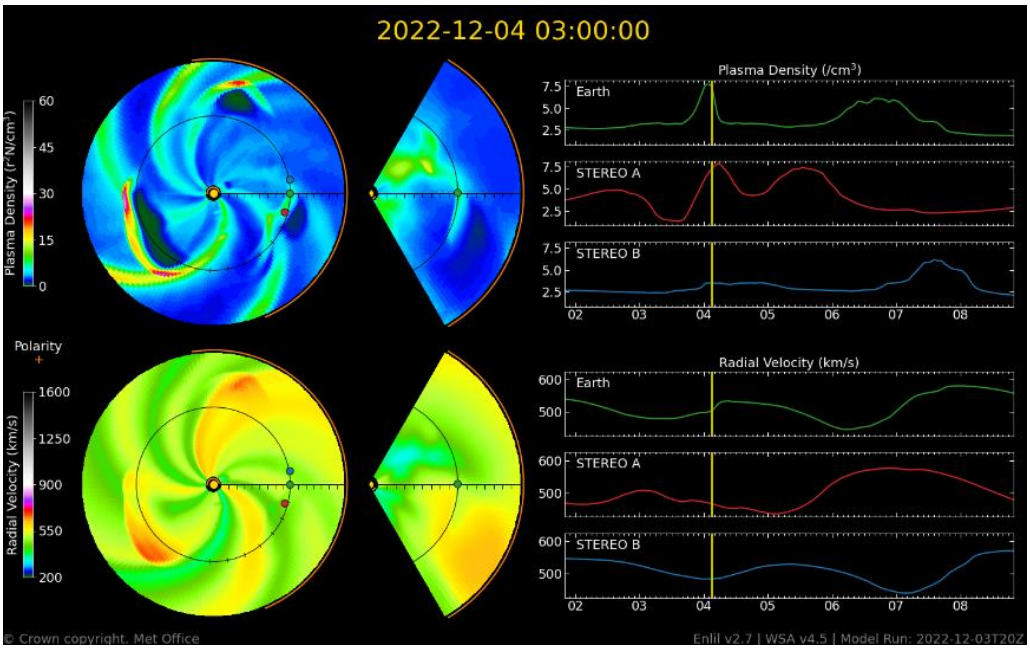


Figure 2b: Solar wind Persistence Model Nil sig enhancement, beyond a passing CME last rotation (showing on 5th to 6th).

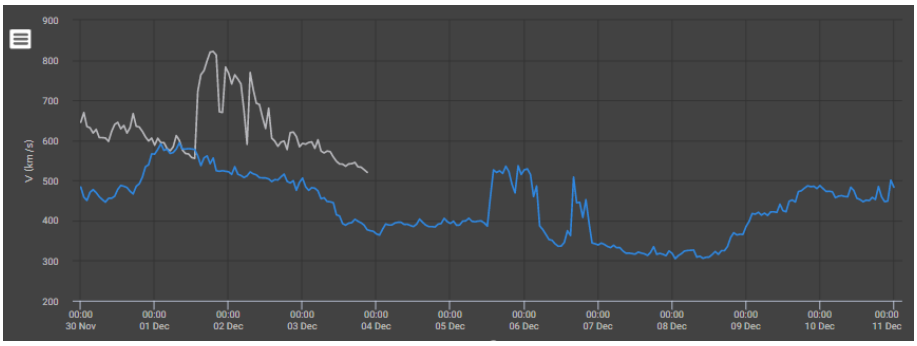
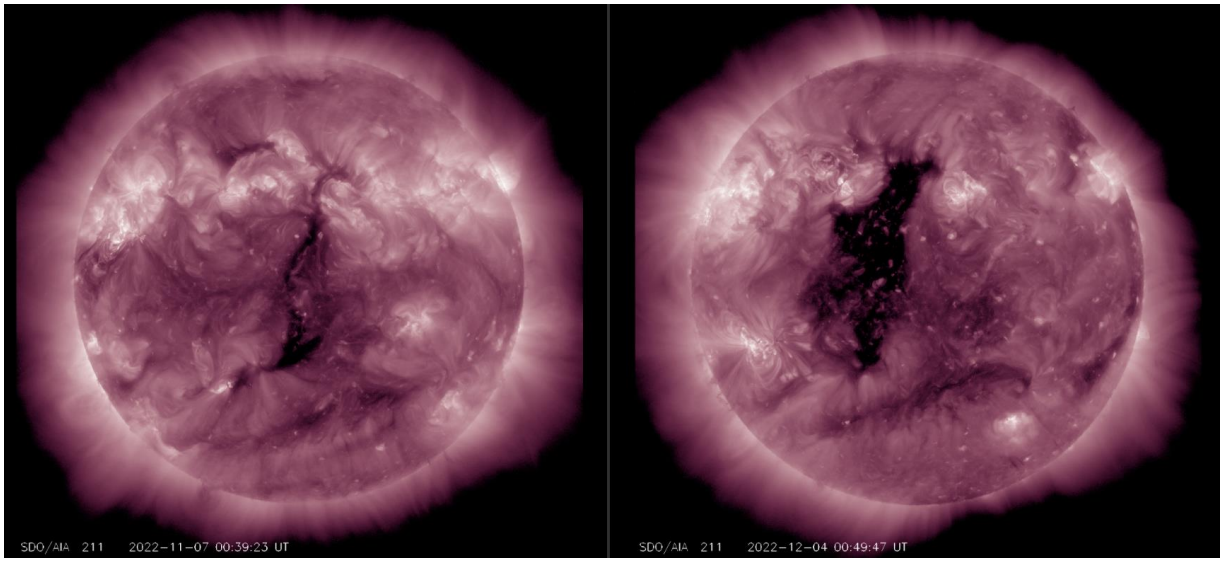


Figure 2c: SDO aia-211 of previous (left) and current (right) rotation Very different coronal hole structure on this rotation.



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Radio Blackouts - X-Ray Flares:

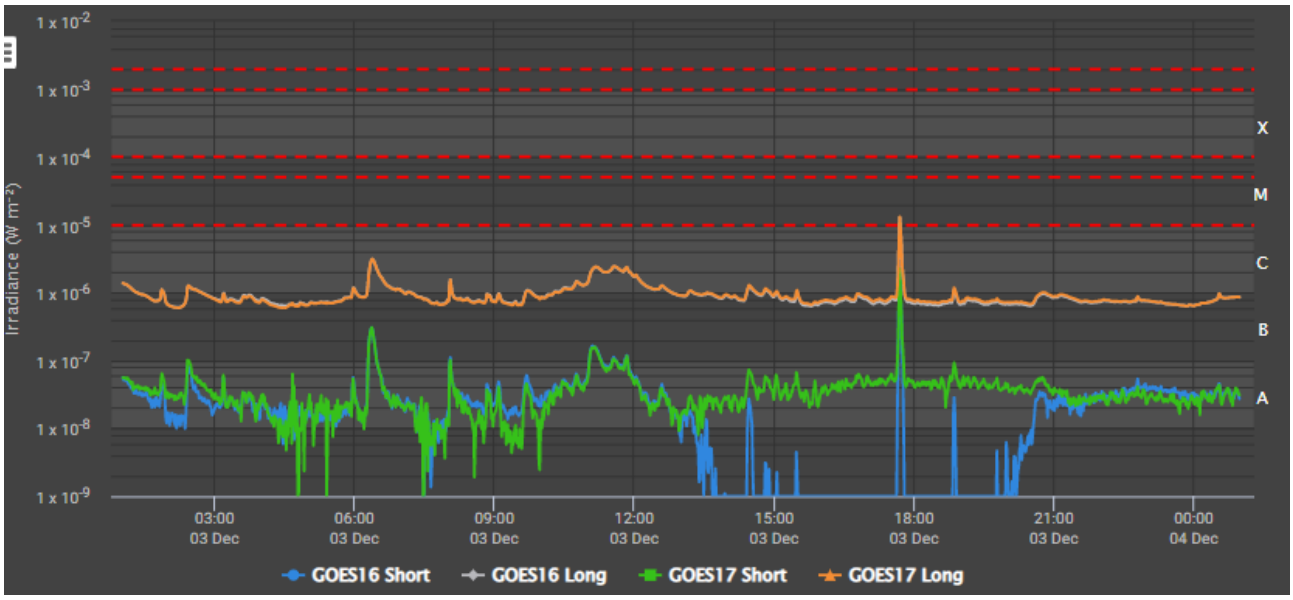
Low solar activity is expected to continue with an ongoing chance of rising to Moderate with further M-class flares.

Large sunspot AR3153 Fho/Beta persists in the southwest, but remains relatively stable. This region has significant magnetic flux associated with it, however its mature appearance, lack of ongoing significant development, and simple magnetic structure, all suggest notable flaring is unlikely from this region.

The main developmental region is AR3155 Dai/Beta, with a proliferation of small spots and some increase in penumbral extent. Although this remains simple with an east-west aligned field. Other areas of development include two very small new spots, to the northwest (Bxo/Beta) and west (Axx/Alpha) of AR3156, although this spot remains a simple stable mature region (Hsx/alpha). A further region has rotated on the northeast limb, and is currently assessed as a relatively simple bipolar region (Cso/Beta), but will need further analysis when as rotates into a clearer view. This was likely the source of the impulsive M1.3 flare on the limb at 03/1741 UTC. AR3154 in the southwest is gradually fading.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16/17 X-ray flux



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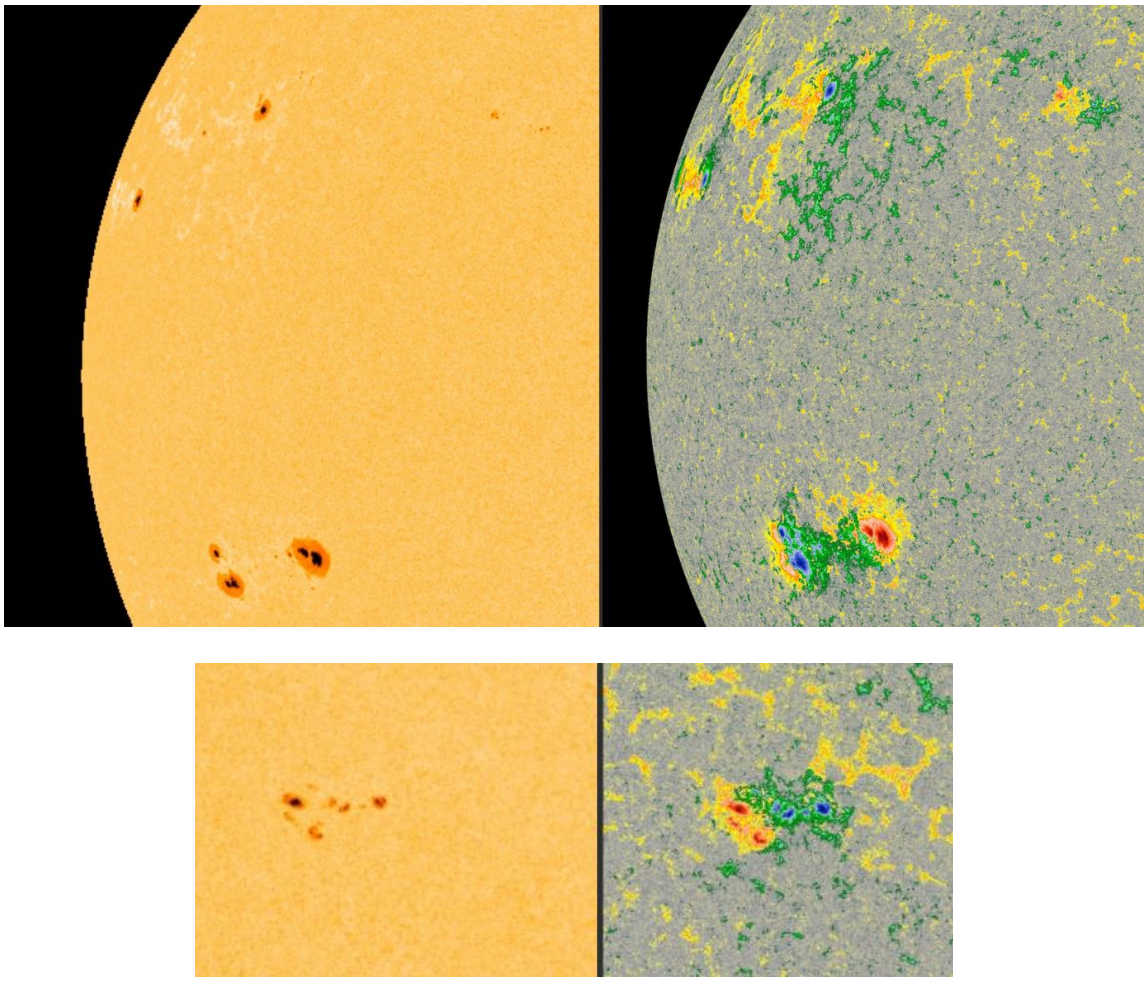
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout the period. However, any significant flares from either AR3153 or AR3155 would give a very slightly above background chance for observed protons at Earth to increase towards the S1/Minor Radiation Storm level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO Intensitygram (left) and magnetogram (right) of eastern hemisphere (top) and zoomed view of AR3155 in NW (bottom)



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently High and in the absence of any disturbance would be expected to persist at these levels until the arrival of the fast wind of CH53 on day 4 (7th). This arrival is then likely to cause the observed flux to drop out towards background. The main source of uncertainty is the potential CME arrival early on day 1 (4th). Despite being a weak CME, any arrival would likely result in flux levels also dropping out for a period, potentially to background, before recovering to uncertain levels, but probably High, as the Van Allen Belts relax back outward later day 1 or day 2 (4th or 5th).

Associated 24 hour fluence is expected to be Active (above 1e8 integrated pfu) for much of the period as indicated by REFM, although the potential CME drop out decreasing confidence from day 2 onward. Fluence is also likely to decrease below Active later day 4 (7th), but will likely start the day above this level. Given the current observed flux, if the CME arrival doesn't occur on day 1 (4th), then it is possible that Very Active (1e9 integrated pfu) could be briefly reached.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	80
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	10	5	1

Figure 5: GOES-16 >2MeV Electron Flux and associated Fluence with REFM.

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